

1 **CLAIMS**

2 What is claimed is:

3 1. A method comprising:  
4 accessing at least a portion of a digital image; and  
5 determining if at least said portion is blurred based on at least one blur  
6 detection process selected from a group of blur detection processes including a  
7 wavelet transform blur detection process, and a Cepstrum analysis blur detection  
8 process.

9  
10 2. The method as recited in Claim 1, wherein said wavelet transform  
11 blur detection process includes:  
12 wavelet transforming at least said portion of said digital image to produce a  
13 plurality of corresponding different resolution levels, each resolution level  
14 including a plurality of bands;  
15 generating at least one edge map for each of said resolution levels; and  
16 detecting blur in at least said portion of said digital image based on said  
17 resulting edge maps.

18  
19 3. The method as recited in Claim 2, wherein detecting blur in at least  
20 said portion of said digital image based on said resulting edge maps further  
21 includes normalizing each of said resulting edge maps.

22  
23 4. The method as recited in Claim 3, wherein normalizing each of said  
24 resulting edge maps further includes discretizing edge information.  
25

1           5.     The method as recited in Claim 4, wherein said edge information  
2 includes edge amplitude data.

3  
4           6.     The method as recited in Claim 3, wherein normalizing each of said  
5 resulting edge maps further includes:

6           normalizing a total edge amplitude of said edge map:

7                     
$$Emap_i(k,l) = Emap_i(k,l) / \max(Emap_i);$$

8           partitioning said edge map into edge map blocks;

9           determining a maximal edge amplitude in each of said edge map blocks and  
10 using it to represent the respective edge map block; and

11           using  $E_{\max_i}$  to denote a discretization result of  $Emap_i$  for each of said edge  
12 map blocks.

13  
14           7.     The method as recited in Claim 2; wherein said plurality of bands  
15 includes at least LL, HL, LH, HH bands.

16  
17           8.     The method as recited in Claim 7, wherein  $I_{lv}, I_{lh}, I_{ld}$  denote  
18  $LH_i, HL_i, HH_i$  bands, respectively, and wherein generating said at least one edge  
19 map for each of said resolution levels further includes constructing said edge map  
20 in scale  $i$  as follows:

21                     
$$Emap_i(k,l) = \sqrt{I_{lv}^2(k,l) + I_{lh}^2(k,l) + I_{ld}^2(k,l)}$$

22           where  $(k, l)$  is the coordinate of a pixel in scale  $i$ .

1           9.     The method as recited in Claim 8, wherein detecting blur in at least  
2 said portion of said digital image based on said resulting edge maps further  
3 includes:

4                 comparing amplitude variations of corresponding edge nodes in at least two  
5 different edge maps of at least two different levels, and

6                 wherein comparing said amplitude variations includes generating a  
7 difference map *Dmap* based on

$$8 \quad Dmap(i, j) = \sqrt{(E \max_3(i, j) - E \max_2(i, j))^2 + (E \max_2(i, j) - E \max_1(i, j))^2}.$$

9  
10           10.    The method as recited in Claim 2, wherein detecting blur in at least  
11 said portion of said digital image based on said resulting edge maps further  
12 includes:

13                 comparing amplitude variations of corresponding edge nodes in at least two  
14 different edge maps of at least two different levels.

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16           11.    The method as recited in Claim 10, wherein comparing said  
17 amplitude variations includes generating a difference map.

18  
19           12.    The method as recited in Claim 10, wherein in said difference map a  
20 position of a plurality of relatively large amplitude values corresponds to at least  
21 one blurred edge.

22  
23           13.    The method as recited in Claim 11, wherein detecting blur in at least  
24 said portion of said digital image based on said resulting edge maps further  
25 includes:

generating a binary difference map  $BDmap$  such that,

$$BDmap(i, j) = 1 \text{ if } Dmap(i, j) > t1$$

$$BDmap(i, j) = 0 \text{ otherwise}$$

where  $t1$  is a first threshold value; and

determining that at least one edge map block  $(i, j)$  is blurred if said corresponding  $BDmap(i, j) = 1$ .

14. The method as recited in Claim 13, further comprising:

determining that at least said portion of said digital image is blurred if an applicable percentage of edge map blocks are determined to be blurred exceeds a second threshold value.

15. The method as recited in Claim 1, wherein said Cepstrum analysis blur detection process includes:

determining a Cepstrum for image data  $I$  as

$$C(f) = \text{real}(FFT^{-1}(\log(|FFT(I)|)))$$

16. The method as recited in Claim 1, wherein said Cepstrum analysis blur detection process includes:

dividing said image into a plurality of parts; and

determining a Cepstrum for each of said parts.

17. The method as recited in Claim 1, wherein said Cepstrum analysis blur detection process includes:

blurring at least one boundary within said image.

1  
2 18. The method as recited in Claim 17, wherein blurring said at least one  
3 boundary within said image further includes:

4 using a point spread function (PSF) to blur at least a part of said image.  
5

6 19. The method as recited in Claim 18, wherein said PSF includes a  
7 circular averaging filter.  
8

9 20. The method as recited in Claim 19, wherein said PSF is used to blur  
10 a plurality of parts  $I_{ij}$  to produce corresponding blurred images  $BI_{ij}$ , where

$$BI_{ij} = \text{real}(FFT^{-1}(FFT(I_{ij}) * FFT(PSF))) .$$

11  
12

13 21. The method as recited in Claim 20, further comprising:  
14 determining an image  $J_{ij}$  that includes a weighted sum of said  $I_{ij}$  and  
15 corresponding  $BI_{ij}$ .  
16

17 22. The method as recited in Claim 21, further comprising:  
18 generating a weighting array wherein  $J_{ij}$  is at least substantially equal to  $I_{ij}$   
19 in its central region and at least substantially equal to said corresponding  $BI_{ij}$  near  
20 at least one edge.  
21

22 23. The method as recited in Claim 22, wherein:

$$J_{ij}(x, y) = \alpha(x, y) * I_{ij} + (1 - \alpha(x, y)) * BI_{ij}(x, y) ; \text{ and}$$

23  
24

further comprising calculating a Cepstral transform to each  $J_{ij}$ :

$$CI_{ij} = \text{real}(FFT^{-1}(\log(|FFT(J_{ij})|))) .$$

25

1  
2 24. The method as recited in Claim 23, further comprising:  
3 binarizing each  $CI_{ij}$ .

4  
5 25. The method as recited in Claim 24, wherein binarizing each  $CI_{ij}$   
6 includes setting  $BCI(x, y) = 1$  if  $CI(x, y) / \max(CI) > t3$ , else otherwise setting  
7  $BCI(x, y) = 0$ , wherein  $t3$  is a third threshold value.

8  
9 26. The method as recited in Claim 24, further comprising calculating an  
10 elongation of each resulting binarized Cepstrum image.

11  
12 27. The method as recited in Claim 26, wherein said elongation includes  
13 a ratio of a maximum length of a chord to a minimum length chord.

14  
15 28. The method as recited in Claim 26, wherein moments are used to  
16 calculate said elongation.

17  
18 29. The method as recited in Claim 28, wherein an  $ij$ th discrete central  
19 moment  $\mu_{ij}$  of a region is defined by

20  
21 
$$\mu_{ij} = \sum_{BCI(x,y)=1} (x - \bar{x})^i (y - \bar{y})^j ,$$

22 where  $(\bar{x}, \bar{y})$  is the centre of the region, and

23  
24 
$$\bar{x} = \frac{1}{n} \sum_{BCI(x,y)=1} x \quad \text{and} \quad \bar{y} = \frac{1}{n} \sum_{BCI(x,y)=1} y ,$$

wherein  $n$  is a total number of points contained in said region equal to an area of said region.

30. The method as recited in Claim 29, wherein said elongation using moments includes an:

$$eccentricity = \frac{\mu_{20} + \mu_{02} + \sqrt{(\mu_{20} - \mu_{02})^2 + 4\mu_{11}^2}}{\mu_{20} + \mu_{02} - \sqrt{(\mu_{20} - \mu_{02})^2 + 4\mu_{11}^2}}.$$

31. The method as recited in Claim 29, wherein a principal axes of inertia is used to define a natural coordinate system for said region, such that

$$\theta = \frac{1}{2} \tan^{-1} \left[ \frac{2\mu_{11}}{\mu_{20} - \mu_{02}} \right].$$

32. The method as recited in Claim 28, further comprising:  
determining that said image includes motion blur if more than about one third of said regions have an elongation larger than a threshold value  $L$  and the maximum difference between a corresponding principal axes is less than a threshold  $\Delta\theta$ .

33. The method as recited in Claim 28, further comprising:  
determining that said image includes out-of-focus blur if more than about one third of said regions have applicable areas that are larger than a threshold area value  $A$  and corresponding elongations that are less than a threshold value  $T$ .

1           34. A computer-readable medium having computer-implementable  
2 instructions suitable for causing at least one processing unit to perform acts  
3 comprising:

4           determining if at least a portion of a digital image is motion blurred or out-  
5 of-focus blurred based on at least one blur detection process selected from a group  
6 of blur detection processes including a wavelet transform blur detection process,  
7 and a Cepstrum analysis blur detection process.

8  
9           35. The computer-readable medium as recited in Claim 34, wherein said  
10 wavelet transform blur detection process includes:

11           wavelet transforming at least said portion of said digital image to produce a  
12 plurality of corresponding different resolution levels, each resolution level  
13 including a plurality of bands;

14           generating at least one edge map for each of said resolution levels; and

15           detecting blur in at least said portion of said digital image based on said  
16 resulting edge maps.

17  
18           36. The computer-readable medium as recited in Claim 35, wherein  
19 detecting blur in at least said portion of said digital image based on said resulting  
20 edge maps further includes normalizing each of said resulting edge maps.

21  
22           37. The computer-readable medium as recited in Claim 36, wherein  
23 normalizing each of said resulting edge maps further includes discretizing edge  
24 information.  
25



1           38. The computer-readable medium as recited in Claim 37, wherein said  
2 edge information includes edge amplitude data.

3  
4           39. The computer-readable medium as recited in Claim 36, wherein  
5 normalizing each of said resulting edge maps further includes:

6           normalizing a total edge amplitude of said edge map:

7                     
$$Emap_i(k,l) = Emap_i(k,l) / \max(Emap_i);$$

8           partitioning said edge map into edge map blocks;

9           determining a maximal edge amplitude in each of said edge map blocks and  
10 using it to represent the respective edge map block; and

11           using  $E_{\max_i}$  to denote a discretization result of  $Emap_i$  for each of said edge  
12 map blocks.

13  
14           40. The computer-readable medium as recited in Claim 35, wherein said  
15 plurality of bands includes at least LL, HL, LH, HH bands.

16  
17           41. The computer-readable medium as recited in Claim 40, wherein  
18  $I_{lv}, I_{lh}, I_{ld}$  denote  $LH_i, HL_i, HH_i$  bands, respectively, and wherein generating said at  
19 least one edge map for each of said resolution levels further includes constructing  
20 said edge map in scale  $i$  as follows:

21                     
$$Emap_i(k,l) = \sqrt{I_{lv}^2(k,l) + I_{lh}^2(k,l) + I_{ld}^2(k,l)}$$

22           where  $(k, l)$  is the coordinate of a pixel in scale  $i$ .

1        42. The computer-readable medium as recited in Claim 41, wherein  
2 detecting blur in at least said portion of said digital image based on said resulting  
3 edge maps further includes:

4        comparing amplitude variations of corresponding edge nodes in at least two  
5 different edge maps of at least two different levels, and

6        wherein comparing said amplitude variations includes generating a  
7 difference map *Dmap* based on

$$8 \quad Dmap(i, j) = \sqrt{(E_{\max_3}(i, j) - E_{\max_2}(i, j))^2 + (E_{\max_2}(i, j) - E_{\max_1}(i, j))^2}.$$

9  
10       43. The computer-readable medium as recited in Claim 35, wherein  
11 detecting blur in at least said portion of said digital image based on said resulting  
12 edge maps further includes:

13       comparing amplitude variations of corresponding edge nodes in at least two  
14 different edge maps of at least two different levels.

15  
16       44. The computer-readable medium as recited in Claim 43, wherein  
17 comparing said amplitude variations includes generating a difference map.

18  
19       45. The computer-readable medium as recited in Claim 43, wherein in  
20 said difference map a position of a plurality of relatively large amplitude values  
21 corresponds to at least one blurred edge.

22  
23       46. The computer-readable medium as recited in Claim 44, wherein  
24 detecting blur in at least said portion of said digital image based on said resulting  
25 edge maps further includes:

1 generating a binary difference map *BDmap* such that,

2 
$$BDmap(i, j) = 1 \text{ if } Dmap(i, j) > t1$$

3 
$$BDmap(i, j) = 0 \text{ otherwise}$$

4 where *t1* is a first threshold value; and

5 determining that at least one edge map block (*i, j*) is blurred if said  
6 corresponding  $BDmap(i, j) = 1$ .

7  
8 47. The computer-readable medium as recited in Claim 46, further  
9 comprising:

10 determining that at least said portion of said digital image is blurred if an  
11 applicable percentage of edge map blocks are determined to be blurred exceeds a  
12 second threshold value.

13  
14 48. The computer-readable medium as recited in Claim 34, wherein said  
15 Cepstrum analysis blur detection process includes:

16 determining a Cepstrum for image data *I* as

17 
$$C(f) = \text{real}(FFT^{-1}(\log(|FFT(I)|)))$$
 .

18  
19 49. The computer-readable medium as recited in Claim 34, wherein said  
20 Cepstrum analysis blur detection process includes:

21 dividing said image into a plurality of parts; and

22 determining a Cepstrum for each of said parts.

23  
24 50. The computer-readable medium as recited in Claim 34, wherein said  
25 Cepstrum analysis blur detection process includes:

1 blurring at least one boundary within said image.

2  
3 51. The computer-readable medium as recited in Claim 50, wherein  
4 blurring said at least one boundary within said image further includes:

5 using a point spread function (PSF) to blur at least a part of said image.

6  
7 52. The computer-readable medium as recited in Claim 51, wherein said  
8 PSF includes a circular averaging filter.

9  
10 53. The computer-readable medium as recited in Claim 52, wherein said  
11 PSF is used to blur a plurality of parts  $I_{ij}$  to produce corresponding blurred  
12 images  $BI_{ij}$ , where

$$BI_{ij} = \text{real}(FFT^{-1}(FFT(I_{ij}) * FFT(PSF))) .$$

14  
15 54. The computer-readable medium as recited in Claim 53, further  
16 comprising:

17 determining an image  $J_{ij}$  that includes a weighted sum of said  $I_{ij}$  and  
18 corresponding  $BI_{ij}$ .

19  
20 55. The computer-readable medium as recited in Claim 54, further  
21 comprising:

22 generating a weighting array wherein  $J_{ij}$  is at least substantially equal to  $I_{ij}$   
23 in its central region and at least substantially equal to said corresponding  $BI_{ij}$  near  
24 at least one edge.

1        56. The computer-readable medium as recited in Claim 55, wherein:

2                     $J_{ij}(x, y) = \alpha(x, y) * I_{ij} + (1 - \alpha(x, y)) * BI_{ij}(x, y)$ ; and

3        further comprising calculating a Cepstral transform to each  $J_{ij}$ :

4                     $CI_{ij} = \text{real}(FFT^{-1}(\log(|FFT(J_{ij})|)))$ .

5  
6        57. The computer-readable medium as recited in Claim 56, further  
7 comprising:

8                    binarizing each  $CI_{ij}$ .

9  
10       58. The computer-readable medium as recited in Claim 57, wherein  
11 binarizing each  $CI_{ij}$  includes setting  $BCI(x, y) = 1$  if  $CI(x, y) / \max(CI) > t3$ , else  
12 otherwise setting  $BCI(x, y) = 0$ , wherein  $t3$  is a third threshold value.

13  
14       ~~59. The computer-readable medium as recited in Claim 57, further~~  
15 comprising calculating an elongation of each resulting binarized Cepstrum image.

16  
17       60. The computer-readable medium as recited in Claim 59, wherein said  
18 elongation includes a ratio of a maximum length of a chord to a minimum length  
19 chord.

20  
21       61. The computer-readable medium as recited in Claim 59, wherein  
22 moments are used to calculate said elongation.

23  
24       62. The computer-readable medium as recited in Claim 61, wherein an  
25  $ij$  th discrete central moment  $\mu_{ij}$  of a region is defined by

$$\mu_{ij} = \sum_{BCI(x,y)=1} (x - \bar{x})^i (y - \bar{y})^j ,$$

where  $(\bar{x}, \bar{y})$  is the centre of the region, and

$$\bar{x} = \frac{1}{n} \sum_{BCI(x,y)=1} x \quad \text{and} \quad \bar{y} = \frac{1}{n} \sum_{BCI(x,y)=1} y ,$$

wherein  $n$  is a total number of points contained in said region equal to an area of said region.

63. The computer-readable medium as recited in Claim 62, wherein said elongation using moments includes an:

$$\text{eccentricity} = \frac{\mu_{20} + \mu_{02} + \sqrt{(\mu_{20} - \mu_{02})^2 + 4\mu_{11}^2}}{\mu_{20} + \mu_{02} - \sqrt{(\mu_{20} - \mu_{02})^2 + 4\mu_{11}^2}} .$$

~~64. The computer-readable medium as recited in Claim 62, wherein a~~  
principal axes of inertia is used to define a natural coordinate system for said region, such that

$$\theta = \frac{1}{2} \tan^{-1} \left[ \frac{2\mu_{11}}{\mu_{20} - \mu_{02}} \right] .$$

65. The computer-readable medium as recited in Claim 61, further comprising:

determining that said image includes motion blur if more than about one third of said regions have an elongation larger than a threshold value  $L$  and the

1 maximum difference between a corresponding principal axes is less than a  
2 threshold  $\Delta\theta$ .

3  
4 66. The computer-readable medium as recited in Claim 61, further  
5 comprising:

6 determining that said image includes out-of-focus blur if more than about  
7 one third of said regions have applicable areas that are larger than a threshold area  
8 value  $A$  and corresponding elongations that are less than a threshold value  $T$ .

9  
10 67. An apparatus comprising:

11 logic operatively configured to access digital image data and determine if at  
12 least a portion of said image is blurry using at least one blur detector selected from  
13 a group of blur detectors comprising a wavelet transform blur detector, and a  
14 Cepstrum analysis blur detector.

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15  
16 68. The apparatus as recited in Claim 67, wherein said wavelet  
17 transform blur detector is operatively configured to wavelet transform at least said  
18 portion to produce a plurality of corresponding different resolution levels with  
19 each resolution level including a plurality of bands, generate at least one edge map  
20 for each of said resolution levels, and detect blur in at least said portion of said  
21 digital image based on said resulting edge maps.

22  
23 69. The apparatus as recited in Claim 68, wherein said wavelet  
24 transform blur detector normalizes each of said resulting edge maps.  
25

1        70. The apparatus as recited in Claim 69, wherein said wavelet  
2 transform blur detector discretizes edge information.

3  
4        71. The apparatus as recited in Claim 70, wherein said edge information  
5 includes edge amplitude data.

6  
7        72. The apparatus as recited in Claim 69, wherein said wavelet  
8 transform blur detector normalizes each of said resulting edge maps by  
9 normalizing a total edge amplitude of said edge map such that  
10  $Emap_i(k,l) = Emap_i(k,l) / \max(Emap_i)$ , partitions said edge map into edge map blocks,  
11 and determines a maximal edge amplitude in each of said edge map blocks and  
12 uses it to represent the respective edge map block, and using  $E_{max_i}$  denotes a  
13 discretization result of  $Emap_i$  for each of said edge map blocks.

---

14  
15        73. The apparatus as recited in Claim 68, wherein said plurality of bands  
16 includes at least LL, HL, LH, HH bands.

17  
18        74. The apparatus as recited in Claim 73, wherein  $I_{lv}, I_{lh}, I_{ld}$  denote  
19  $LH_i, HL_i, HH_i$  bands, respectively, and wherein said wavelet transform blur detector  
20 constructs said edge map in scale  $i$  as follows:

21                    
$$Emap_i(k,l) = \sqrt{I_{lv}^2(k,l) + I_{lh}^2(k,l) + I_{ld}^2(k,l)}$$

22        where  $(k, l)$  is the coordinate of a pixel in scale  $i$ .

23  
24        75. The apparatus as recited in Claim 74, wherein said wavelet  
25 transform blur detector compares amplitude variations of corresponding edge



1 nodes in at least two different edge maps of at least two different levels, and  
2 generates a difference map *Dmap* based on

$$3 \quad Dmap(i, j) = \sqrt{(E_{\max_3}(i, j) - E_{\max_2}(i, j))^2 + (E_{\max_2}(i, j) - E_{\max_1}(i, j))^2} .$$

4  
5 76. The apparatus as recited in Claim 68, wherein said wavelet  
6 transform blur detector compares amplitude variations of corresponding edge  
7 nodes in at least two different edge maps of at least two different levels.

8  
9 77. The apparatus as recited in Claim 76, wherein said wavelet  
10 transform blur detector generates a difference map.

11  
12 78. The apparatus as recited in Claim 76, wherein in said difference map  
13 a position of a plurality of relatively large amplitude values corresponds to at least  
14 one blurred edge.

---

15  
16 79. The apparatus as recited in Claim 77, wherein said wavelet  
17 transform blur detector generates a binary difference map *BDmap* such that,

$$18 \quad BDmap(i, j) = 1 \text{ if } Dmap(i, j) > t1$$

$$19 \quad BDmap(i, j) = 0 \text{ otherwise}$$

20 where *t1* is a first threshold value; and  
21 determines that at least one edge map block (i, j) is blurred if said  
22 corresponding *BDmap*(i, j) = 1 .

23  
24 80. The apparatus as recited in Claim 79, wherein said wavelet  
25 transform blur detector determines that at least said portion of said digital image is

1 blurred if an applicable percentage of edge map blocks are determined to be  
2 blurred exceeds a second threshold value.

3  
4 81. The apparatus as recited in Claim 67, wherein said Cepstrum  
5 analysis blur detector determines a Cepstrum for image data  $I$  as

$$6 \quad C(f) = \text{real}(FFT^{-1}(\log(|FFT(I)|))) .$$

7  
8 82. The apparatus as recited in Claim 67, wherein said Cepstrum  
9 analysis blur detector divides said image into a plurality of parts, and determines a  
10 Cepstrum for each of said parts.

11  
12 83. The apparatus as recited in Claim 67, wherein said Cepstrum  
13 analysis blur detector selectively blurs at least one boundary within said image.

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14  
15 84. The apparatus as recited in Claim 83, wherein said Cepstrum  
16 analysis blur detector uses a point spread function (PSF) to selectively blur at least  
17 a part of said image.

18  
19 85. The apparatus as recited in Claim 84, wherein said PSF includes a  
20 circular averaging filter.

21  
22 86. The apparatus as recited in Claim 85, wherein said PSF blurs a  
23 plurality of parts  $I_{ij}$  to produce corresponding blurred images  $BI_{ij}$ , where

$$24 \quad BI_{ij} = \text{real}(FFT^{-1}(FFT(I_{ij}) * FFT(PSF))) .$$

25

1        87. The apparatus as recited in Claim 86, wherein said Cepstrum  
2 analysis blur detector determines an image  $J_{ij}$  that includes a weighted sum of said  
3  $I_{ij}$  and corresponding  $BI_{ij}$ .

4  
5        88. The apparatus as recited in Claim 87, wherein said Cepstrum  
6 analysis blur detector generates a weighting array wherein  $J_{ij}$  is at least  
7 substantially equal to  $I_{ij}$  in its central region and at least substantially equal to said  
8 corresponding  $BI_{ij}$  near at least one edge.

9  
10       89. The apparatus as recited in Claim 88, wherein  
11  $J_{ij}(x, y) = \alpha(x, y) * I_{ij} + (1 - \alpha(x, y)) * BI_{ij}(x, y)$ ; and  
12 said Cepstrum analysis blur detector calculates a Cepstral transform to each  
13  $J_{ij}$  such that  $CI_{ij} = \text{real}(FFT^{-1}(\log(|FFT(J_{ij})|)))$ .

---

14  
15       90. The apparatus as recited in Claim 89, wherein said Cepstrum  
16 analysis blur detector binarizes each  $CI_{ij}$ .

17  
18       91. The apparatus as recited in Claim 90, wherein said Cepstrum  
19 analysis blur detector binarizes each  $CI_{ij}$  by setting  $BCI(x, y) = 1$  if  
20  $CI(x, y) / \max(CI) > t3$ , else otherwise setting  $BCI(x, y) = 0$ , wherein  $t3$  is a third  
21 threshold value.

22  
23       92. The apparatus as recited in Claim 90, wherein said Cepstrum  
24 analysis blur detector calculates an elongation of each resulting binarized  
25 Cepstrum image.

93. The apparatus as recited in Claim 92, wherein said elongation includes a ratio of a maximum length of a chord to a minimum length chord.

94. The apparatus as recited in Claim 92, wherein said Cepstrum analysis blur detector uses moments to calculate said elongation.

95. The apparatus as recited in Claim 94, wherein an  $ij$ th discrete central moment  $\mu_{ij}$  of a region is defined by

$$\mu_{ij} = \sum_{BCI(x,y)=1} (x - \bar{x})^i (y - \bar{y})^j ,$$

where  $(\bar{x}, \bar{y})$  is the centre of the region, and

$$\bar{x} = \frac{1}{n} \sum_{BCI(x,y)=1} x \quad \text{and} \quad \bar{y} = \frac{1}{n} \sum_{BCI(x,y)=1} y ,$$

wherein  $n$  is a total number of points contained in said region equal to an area of said region.

96. The apparatus as recited in Claim 95, wherein said elongation using moments includes an:

$$eccentricity = \frac{\mu_{20} + \mu_{02} + \sqrt{(\mu_{20} - \mu_{02})^2 + 4\mu_{11}^2}}{\mu_{20} + \mu_{02} - \sqrt{(\mu_{20} - \mu_{02})^2 + 4\mu_{11}^2}} .$$

1           97. The apparatus as recited in Claim 95, wherein said Cepstrum  
2 analysis blur detector uses a principal axes of inertia to define a natural coordinate  
3 system for said region, such that

4

$$\theta = \frac{1}{2} \tan^{-1} \left[ \frac{2\mu_{11}}{\mu_{20} - \mu_{02}} \right].$$

6

7

8           98. The apparatus as recited in Claim 94, wherein said logic determines  
9 that said image includes motion blur if more than about one third of said regions  
10 have an elongation larger than a threshold value  $L$  and the maximum difference  
11 between a corresponding principal axes is less than a threshold  $\Delta\theta$ .

12

13           99. The apparatus as recited in Claim 94, wherein said logic determines  
14 ~~that said image includes out-of-focus blur if more than about one third of said~~  
15 regions have applicable areas that are larger than a threshold area value  $A$  and  
16 corresponding elongations that are less than a threshold value  $T$ .

17

18           100. The apparatus as recited in Claim 67, wherein said apparatus  
19 includes at least one device selected from a group of devices comprising a  
20 computer, a camera, a set top box, an optical disc player, an optical disc player  
21 recorder, a portable communication device, a display device, a television set, and a  
22 projector.

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